Space Weather Technical Forecast

Issued on Tuesday, 08 November 2022 at 13:10 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of M-class flares (R1; Minor radio blackouts) throughout. Very slight chance of G1/Minor storms.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low, with several low C-class flares observed in the past 24 hours, largely from AR3141. There are six numbered sunspot regions and one unnumbered group on the visible disc. AR3141 in the east remains the largest, most active and complex group, classified as Eko/Beta-gamma. Some very small, weak spots of mixed magnetic field remain apparent in the intermediate portion of the group, a potential sign of increasing complexity though overall size has reduced somewhat. AR3140 is the second largest region, with a moderately sized mature spot, Hsx/Alpha, though the region remains inactive. The only other moderately sized unipolar spot remains AR3135, a Hsx/Alpha in the far northwestern hemisphere. All other spots are small and relatively simple. No Earth-directed CMEs have been observed.

Solar Wind / Geomagnetic Activity: The solar wind, observed by ACE/DSCOVR at L1, has been generally slow-ambient with averages around 380-390km/s, and occasional increases to slightly elevated levels, with peaks around 410km/s. Density was average to above average levels to start the period, erratically decreasing back to near average levels after 07/1800 UTC. This is suspected to be due to the clearance of a slow CME cloud from Earth, density decreased further to below average levels from 08/0600 UTC. Total magnetic field strength, IMF, has been generally moderate. A brief strong interval was observed between 07/1630-07/1715 UTC, with a peak value of 15.7nT at 07/1655 UTC. The north-south component, Bz was moderately negative between 07/1200-1745 UTC, with a peak value of -14.6nT at 07/1656 UTC. Through the middle part of the period Bz has been predominantly weak to moderate and positive, but returned to moderate negative from 08/0600 UTC. Phi angle has been mostly positive (away from the Sun). Geomagnetic activity increased to reach Minor Storm/G1 (Kp5) levels between 07/1500-2100 UTC, before easing back to Quiet to Active levels (Kp2-4).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES-16 has remained at background levels. High energy electron flux (greater than 2 MeV) at GOES-16 was at high levels initially, with a peak of 4.75e3 pfu at 07/1330UTC. Following the arrival of the CME, electron flux dramatically reduced, becoming predominantly background from 07/1640 UTC. Electron fluence levels have been above the Active threshold for much of the period, though with rapidly declining trend have fallen back below the active threshold from 08/0900 UTC. A value of 2.89e7 integrated pfu was observed at 08/1200 UTC.

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Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to be generally Low, with a chance of Moderate activity and a continuing very slight chance of High levels of activity.

Solar Wind / Geomagnetic Activity: Geomagnetic activity is expected to be mainly Quiet to Unsettled given generally slow-ambient solar winds, but there is a chance of Active intervals at times given any prolonged periods of negative Bz and approaching coronal hole high speed streams. There is a very slight chance of G1/Minor Storm intervals, mainly due to the possible arrival of one or more coronal hole high speed streams in the coming days.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) observed by GOES-16 is expected to be at background levels. High energy electron flux (greater than 2MeV) is expected to be at background to moderate levels for much of the period, possibly increasing to high levels at times of diurnal maxima. Electron fluence values expected to remain below the Active (1e8 integrated pfu) threshold.

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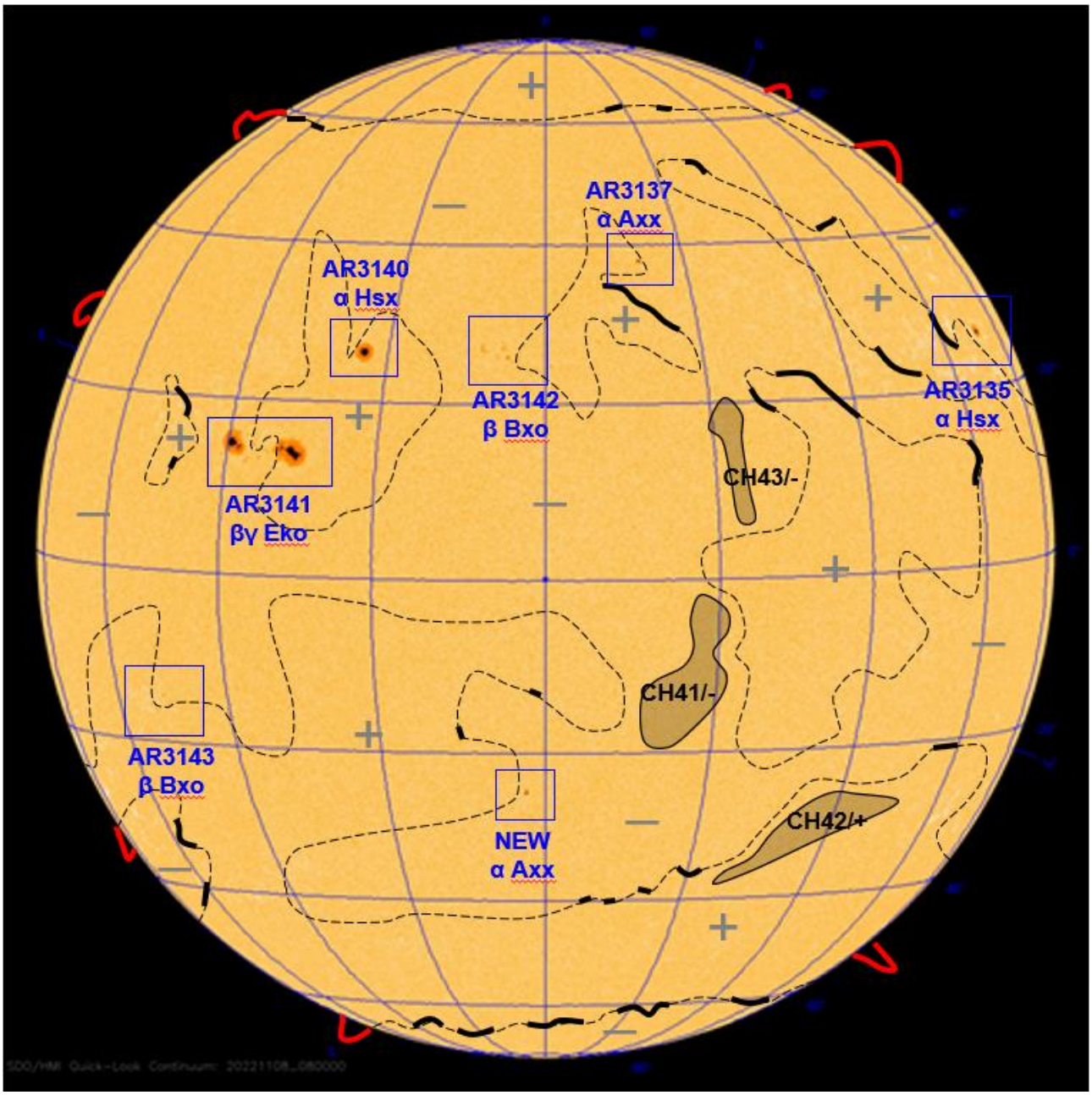
Figure 1. Solar Analysis Valid 08/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No Earth directed CMEs currently feature in the forecast. A number of filaments are present on the Earth-facing disc and will be monitored for any potential lift-offs or eruptions.

Solar wind speeds are currently slow-ambient to slightly elevated, with speeds between 360-380km/s. Influence from the elongated Coronal hole 42 in the south of the disk may see an increase in speeds at times, although there is low confidence in the strength of any connection. Indeed STEREO A has not apparently observed any connection to this feature so far. There is a greater likelihood that Earth may connect to coronal holes 41 or 43 later on day 2 or most likely into day 3 (9th or 10th Nov). However any impact at the Earth is expected to be fairly limited due to their negative polarity as we slowly edge away from the autumn equinox.

Geomagnetic activity is expected to be mainly Quiet to Unsettled, with a chance of Active intervals at times given any prolonged periods of negative Bz and approaching coronal hole high speed streams. There is a very slight chance of G1/Minor Storm intervals either due to residual influence of the recent CME impact during day 1 (8th), or from the possible arrival of coronal hole high speed streams during early hours of days 2 and 3.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	10	10	10	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity – Earthbound Coronal Mass Ejections

Nil.

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Radio Blackouts - X-Ray Flares:
There are six numbered sunspot regions and one unnumbered group on the visible disc. AR3141 in the east remains the largest, most active and complex group, classified as Eko/Beta-gamma. Some small, weak spots of mixed magnetic field remain apparent in the intermediate portion of the group, a potential sign of increasing complexity. AR3140 is the second largest region, with a moderately sized mature spot, Hsx/Alpha, though the region remains inactive. The only other moderately sized unipolar spot remains AR3135, a Hsx/Alpha in the far northwestern hemisphere. All other spots are small and relatively simple.

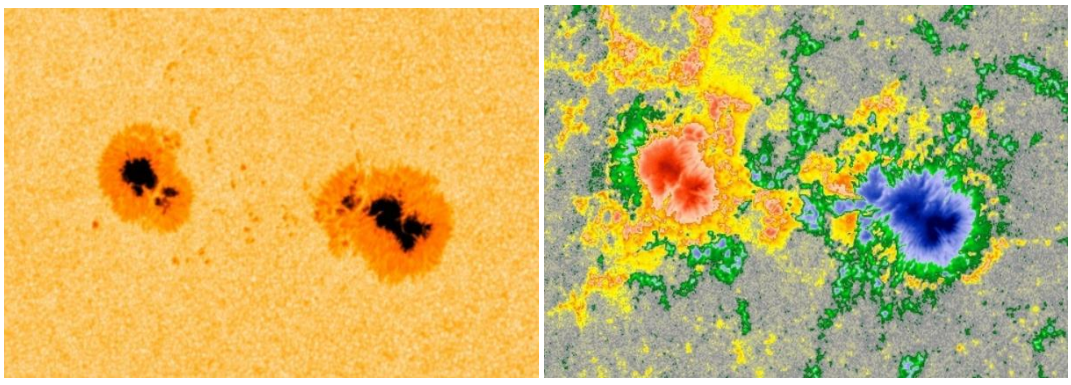
STEREO-A EUVI imagery suggests a new bright region of flux will rotate over the eastern limb (at around 25-30S) late day 1 (8th) or early day 2 (9th). This area may contain one or more sunspot groups that could supplement the present risk of significant flares. Additionally two Strong Active Regions (SARs) recognised in the far hemisphere by the Strong Active Region Discriminator (SARD), are expected to reach the east limb early on day 3 (10th). This also may increase the risk for significant flares.

Solar activity has been Low, with only one significant C-class flare observed in the past 24 hours, from AR3141. Activity is expected to remain largely Low, but there is a chance throughout of isolated M-class flares, most likely from AR3141, giving Moderate solar activity.

There remains a very slight chance of isolated X-class flares and solar activity reaching High levels throughout the period.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	30	40	50	50
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 2: AR3141 as viewed in HMI Intensitygram Flat Orange (left) and HMI Colorized Magnetogram (right) at 08/1215 UTC.



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Solar Radiation Storms - (High Energy Protons):
The high energy proton flux (greater than 10 MeV) at GEO, observed by GOES-16 is currently at background levels and is forecast to generally remain at this level through the guidance period.

A very minor increase in proton storm probabilities is included from day 2 (9th) as AR3141, with the very slight risk of High solar activity, moves into a more effective position relative to Earth.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	2	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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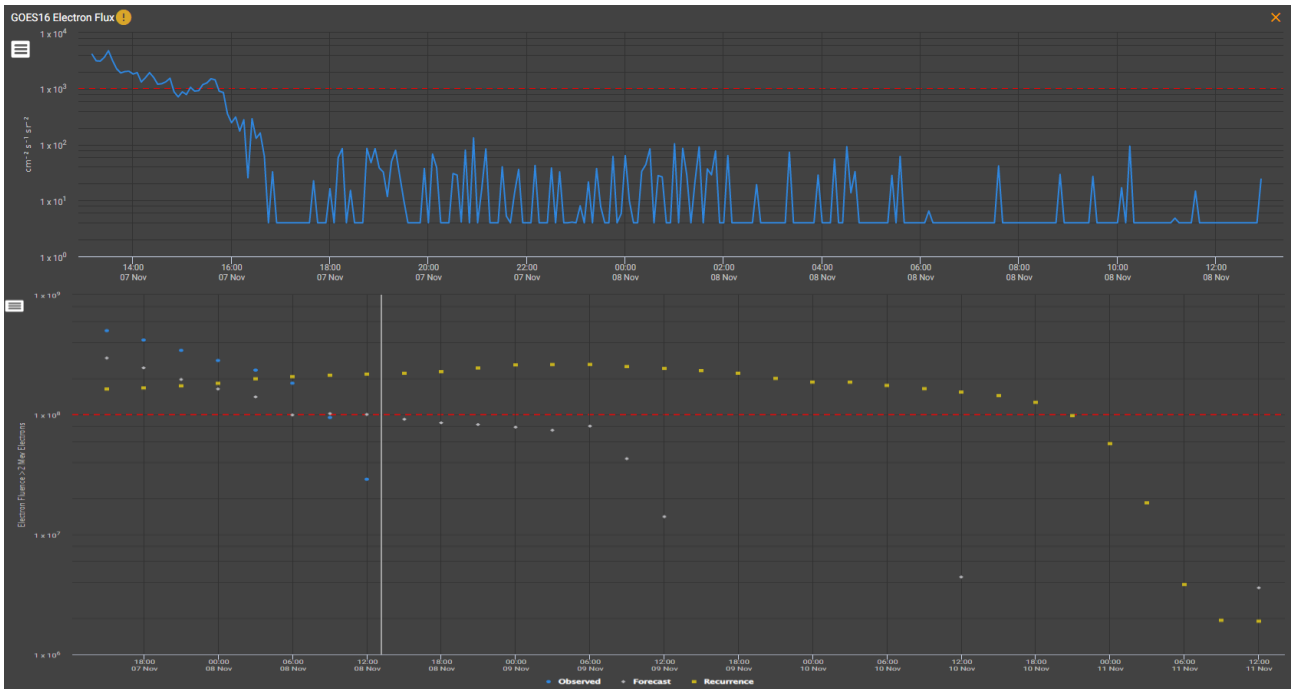
High Energy Electrons Event (≥ 2MeV):
The high energy electron flux (greater than 2MeV) though initially high over the past 24 hours, dropped dramatically with the CME arrival on the 7th, significantly suppressing electron counts to background or moderate levels. Background to moderate levels are now expected to be maintained for much of the period, possibly increasing to high levels at times of diurnal maxima.

Electron fluence values have fallen below the Active (1e8 integrated pfu) threshold and is expected to remain below in the coming days. Confidence in this forecast is high initially. This lowers to moderate by the end of the period given uncertainties over the duration and strength of any geomagnetic activity resulting from one or more forecast high speed streams that are due to affect Earth.

GEO Electron Environment Probability (Exceedance)	Level ($cm^{-2}\ sr^{-1}\ day^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	10	5	5	10
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 3: GOES-16 Electron Flux and MOSWOC REFM fluence observations and model.



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